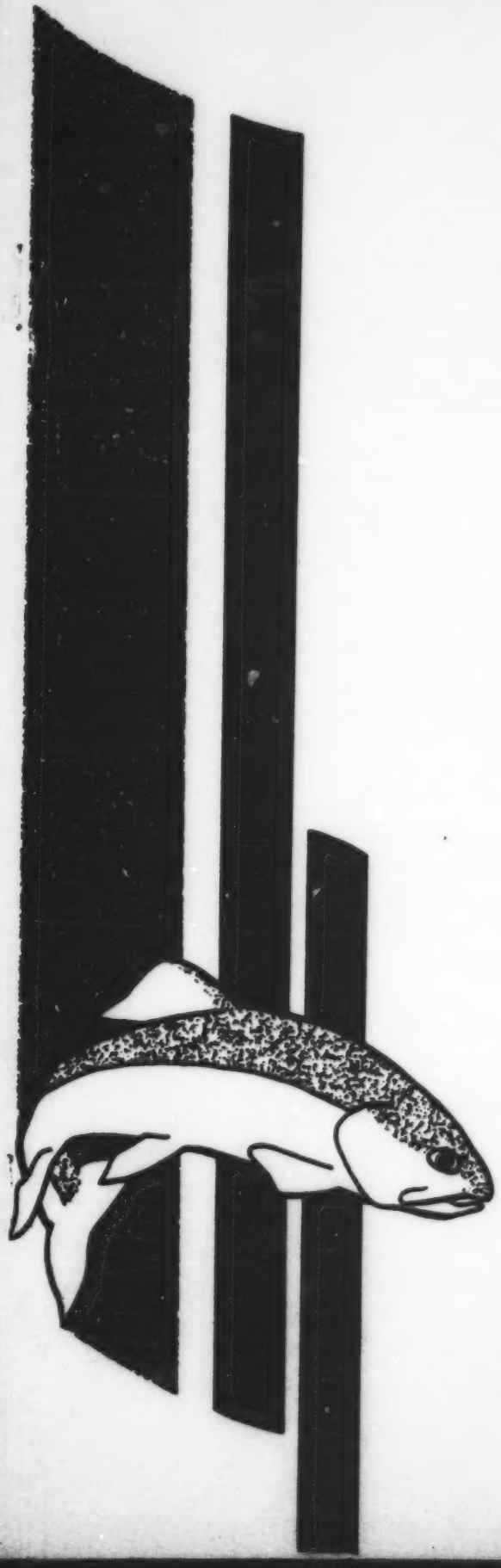

Estimation of Angler Effort Using Index Boat Counts.

by

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ABSTRACT

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Single strata (midday weekend) boat counts as conducted by the Small Lakes Index Management (SLIM) program were compared to estimates of angler effort from intensive angler activity surveys on 19 British Columbia lakes. Angler activity in total boat hours was estimated as 1286 times the simulated SLIM boat count (R^2 = 0.97; CV = 30.6). Shore angler activity (hours) was estimated as 644 times the simulated SLIM shore angler count (R^2 = 0.59; CV = 88.2). Boat angler hours was estimated by multiplying boat hours by the average number of anglers per boat, and angler days by dividing angler hours by the number of hours per angler day. Large CV values reflect a high degree of variability in the data, resulting in large differences between actual and predicted effort estimates, demonstrating the need for flexible interpretation of predictions. Interpretation of the estimates to account for known variations in effort distribution over the day and between daytypes, and angling season length are discussed.

ACKNOWLEDGEMENTS

Raw data for the angler activity surveys was provided by C. Bull, B. Chan, M. Lirette and B. Westover. Specific aspects of the historical surveys were gained through discussion with the above and B. Jantz, S. Matthews, D. Smith, A. Martin and C. Houston. The manuscript was reviewed and edited by E. Parkinson, who also provided valuable advice regarding data analysis and interpretation.

INTRODUCTION

Aerial boat counts are conducted in British Columbia as part of the Small Lakes Index Management (SLIM) program. The SLIM program is a data collection system which involves collection of a minimum of CPUE, fish size, fish age and growth rate data from angler interviews, and effort data from aerial counts (Parkinson 1990; Parkinson et al. 1988). The aerial boat count program is designed to develop and monitor a standard index of angler activity by capturing "instantaneous boat counts" at a single time strata (midday on weekends) throughout the summer (open water) angling season. The SLIM boat count program annually covers approximately 400 lakes. Flight patterns, dates and times are standardized to allow for consistent comparisons across regions and years.

The objective of this paper is to improve the estimates of total angler effort that are generated from boat counts made from SLIM program single time strata sampling. Bull and Houston (1985) developed a regression relating midday weekend boat counts to total angler effort on B.C. lakes. Lester et al. (1991) used midday activity sampling for estimating angler effort on Ontario lakes. In this paper, relationships between boat counts and total summer angler effort as determined by intensive angler activity survey projects are investigated. Results will be used to estimate total angler effort based on boat counts from the SLIM program.

METHODS

Historic angler activity survey data from 19 lakes with complete or near complete season coverage was gathered from regional sources. All surveys used the instantaneous boat count methodology (Malvestuto 1983) where all boats (and shore anglers) actively engaged in fishing are counted at specified times. Survey stratification schemes and sample size (number of counts) varied among the projects. All data was analyzed using a standardized spreadsheet. Four different stratification schemes were used in the analysis (all counts, by daytype, by month, by month and daytype). Results of the latter stratification were used for further analysis.

Mean boat counts were calculated for each strata:

(1) $$C_k = (\sum_k C) \cdot N^{-1}$$

Total effort (boat hours) was calculated from the mean boat count for each strata:

(2) $$E_{BH} = \sum_{k} (C_k \cdot t_k)$$

where E_{BH} is total effort in boat hours, C_k is mean boat count in the k^{th} strata and t_k is the number of hours in the k^{th} strata.

Angler hours (E_{BAH}) and angler days (E_{BAD}) were calculated by adjusting E_{BH} for the average number of anglers per boat and the average number of hours per angler day. Shore angler hour (E_{SAH}) and angler day (E_{SAD}) calculations were identical. The number of anglers per boat and hours per angler day was taken from paired angler interview data where available, or default values of 2 anglers per boat and 4 hours per angler day were used. Available hours (t) were calculated per strata based on the number of days per strata times a standard monthly number of hours per day. The length of angling season was determined from estimates by regional biologists. In cases where a portion of the angling season or a strata was not sampled, counts were extrapolated based on the regional biologists estimate of effort in relation to counts from adjacent sampled strata.

Simulated SLIM counts were calculated from mean boat and shore angler counts from the angler survey data:

(3) $$C_{SLIM} = \left(\sum_{k} (C_k \cdot W_k)\right) \cdot 20^{-1}$$

where C_{SLIM} is the mean simulated SLIM count, C_k is the mean count by month, and W_k is a weighting factor to reflect the SLIM program sample weighting (May = 6, June = 6, July = 2, August = 4, September = 2).

Midday was defined as 0900 to 1600 hours inclusive, to reflect the span of current SLIM program flight scheduling. Weekends included long weekend days.

The relationship between the simulated SLIM boat count and total angler effort was investigated through regression analysis (SAS 1982). The effort variables used for analysis were boat hours and shore angler hours. Effort distribution over the day, over the season and by daytypes was also investigated.

RESULTS

Angler Activity Surveys

A summary of angler activity survey results for 19 B.C. lakes is given in Table 1. Estimated boat hours ranged from 520 in Headwaters Lake No. 3 up to 66,680 in Sheridan Lake. These translate to 282 and 23,851 angler days respectively. Shore anglers were counted on 8 of the lakes. Shore angler hours ranged from 48 in Headwaters Lake No. 3 up to 1452 in Whiteswan Lake, or 12 to 363 angler days respectively. Some of the estimates may vary from those values reported in original project reports because of the standardized approach used in this analysis.

Relationships between boat hours, angler hours and angler days vary for each lake depending on the lake specific values of variables used for conversions. The average number of anglers per boat was 1.91, and ranged from 1.54 in Pass Lake up to 2.42 in Headwaters Lake No. 1. The number of hours fished per angler day averaged 3.6 hours and ranged from 2.8 in Dragon Lake up to 5.2 in Sheridan Lake. Many surveys used the default values of 2 anglers per boat and 4 hours per angler day. These variables can have quite an impact on the angler day estimate from a given boat hour estimate as indicated in Table 1. As only boat and angler count data is generated by the SLIM flights one might expect a better relationship between boat (or shore angler) hours and mean boat (or shore angler) count. Boat hours was therefore chosen for further analysis being as the most fundamentally related to boat counts.

Effects of Stratification

An analysis of unstratified versus fully stratified (month and daytype) boat hour estimates is summarized in Table 2. Stratified estimates were lower in 16 of 19 lakes, and were on average 85% of the unstratified boat hour estimates. The index of precision (Elliot 1971) was lower in all but 1 of the stratified analyses, and averaged 0.102 for unstratified and 0.078 for stratified analyses. Stratification of these surveys tended to reduce the effects of non-random activity sampling (overestimates caused by sampling more in high use time periods), and resulted in more precise estimates in most cases.

Table 1. Summary of angler activity survey results and simulated SLIM counts for 19 B.C. lakes. Activity is estimated from stratified (month, daytype) analyses of counts.

	Year	Anglers per Boat	Angler Day Length (Hrs)		Boat Angler Activity			Shore Angler Activity		Simulated SLIM Counts (C_{SLIM})	
			Boat	Shore	Boat Hours	Angler Hours	Angler Days	Angler Hours	Angler Days	Boats	Shore Anglers
Chimney	1987	2.00[1]	3.5		4,106	8,211	2,346			3.70	
Dragon	1987	2.00[1]	2.8		4,382	8,764	3,130			4.32	
Dugan	1987	2.00[1]	3.0		1,855	3,708	1,236			1.72	
Fawn	1987	2.00[1]	3.6		6,092	12,182	3,384			3.10	
Headwater 1	1985	2.42	4.0[2]	4.0[2]	3,754	9,080	2,270	796	199	5.73	1.21
Headwater 2	1985	1.73	4.0[2]	4.0[2]	877	1,515	379	60	15	1.15	0.15
Headwater 3	1985	2.17	4.0[2]	4.0[2]	518	1,128	282	48	12	0.98	0.13
Jacko	1986	1.75	4.0[2]		15,146	26,502	6,626			8.47	
Lady King	1985	2.02	4.0[2]	4.0[2]	2,343	4,735	1,184	160	40	2.57	0.21
Pass	1987	1.54	4.0[2]		8,812	13,570	3,393			3.98	
Pinaus	1985	1.99	4.0[2]	4.0[2]	10,156	20,210	5,053	492	123	11.32	0.87
Postill	1985	1.91	4.0[2]	4.0[2]	1,717	3,278	819	828	207	2.86	1.77
Puntzi	1986	1.86	4.0[2]		6,653	12,373	3,093			3.06	
Sheridan	1987	1.86	5.2		66,678	124,024	23,851			47.70	0.19
Sugar	1985	2.03	4.0[2]	4.0[2]	4,654	9,444	2,361	112	28	5.82	0.54
Swalwell	1981	2.00[1]	4.0[2]		19,120	38,240	9,560			24.00	
White	1989	1.70	4.0[2]		49,224	83,681	20,920			37.52	
Whitesewan	1988	1.80	4.0[2]	4.0[2]	19,728	35,510	8,878	1,452	363	13.29	
Whitetail	1987	2.00[1]	4.0[2]		12,628	25,256	6,314			10.08	

[1] default value of 2 anglers per boat used.
[2] default value of 4 hours per angler day used.

Table 2. Effects of stratification of angler activity survey data on magnitude and precision of boat hour estimates.

Lake	N	Unstratified[1]			Fully Stratified[2]			
		Boat Hours	SE	D[3]	Boat Hours	% Unstratified	SE	D
Chimney	94	4240	527	.124	4106	96.8	424	.103
Dragon	96	4775	727	.152	4382	91.8	513	.117
Dugan	96	1954	252	.129	1854	94.9	217	.117
Fawn	96	6006	459	.076	6092	101.4	435	.071
Headwater 1	237	5578	350	.063	3752	67.3	164	.044
Headwater 2	61	817	199	.244	876	107.3	150	.171
Headwater 3	66	614	140	.228	518	84.4	84	.162
Jacko	106	16140	1207	.074	15146	92.3	1169	.077
Lady King	377	2930	168	.057	2343	80.0	105	.045
Pass	33	9969	1027	.103	8812	88.4	860	.098
Pinaus	382	13386	558	.042	10156	75.9	292	.029
Postill	363	2507	176	.070	1717	68.5	97	.056
Puntzi	96	6580	662	.101	6653	101.1	377	.057
Sheridan	54	76818	7001	.091	66678	86.8	3896	.058
Sugar	282	7888	515	.065	4654	59.0	234	.050
Swalwell	154	26506	1805	.068	19120	72.1	856	.045
White	111	54972	4919	.089	49224	89.5	3106	.063
Whiteswan	154	24222	1612	.067	19728	81.4	927	.047
Whitetail	64	16869	1656	.098	12627	74.9	947	.075
Mean				.102		84.9		.078

1. Unstratified = C_{ALL} * t_{ALL}
2. Stratified by month and daytype
3. D = SE / arithmetic mean (Elliott 1971)

Daily Angling Patterns

Parkinson et al. (1988) found boat counts made at noon were not significantly different than those made at 1000 and 1600 hrs. Distribution of angler activity over the day (weekends only) was investigated using the ratio of activity (boat count) at time (t) to mean daily activity (K_t value; Lester et al. 1991) to verify the use of 0900 to 1600 as midday. For all lakes combined the average K_t value for midday was 1.13, or midday activity was 1.13 times the daily average (Fig. 1; Appendix 1). A clear peak was observed for the 1000 to 1200 time period. While the peak in K_t is present, it covers too short a time period to be targetted by the SLIM program. Its presence emphasizes the need for consistency in flight timing for monitoring long term trends by index sampling.

Effort vs Mean Count Regression

Estimated boat and shore angler hours and simulated SLIM count data (Table 1) were used in a linear regression analysis to examine the feasibility of estimating total effort from counts. The simulated SLIM count was a good predictor ($R^2 = 0.97$) of total boat hours (Fig. 2) when data from all 19 lakes was used. While the lakes with high simulated SLIM counts do have high influence on the regression coefficient, inspection of Fig. 2 and analysis of data over a narrower range of values indicates it is not enough to cause serious bias. The all lakes regression was therefore considered best for estimating boat hours as it covers the complete range. Despite the high R^2 value for the boat hour relationship, the accuracy of estimates for individual lakes vary. The coefficient of variation (CV) indicates that deviations from the regression average 30.6 % of the mean. Inspection of Fig. 2 suggests that errors are particularly serious on lakes with low mean counts.

The shore angler hour versus simulated SLIM shore angler count regression for the 8 lakes (Fig. 3) showed much greater variabliity as indicated by relatively low R^2 value (0.59) and high CV (88.2). Predictive power of this relationship is therefore relatively weak.

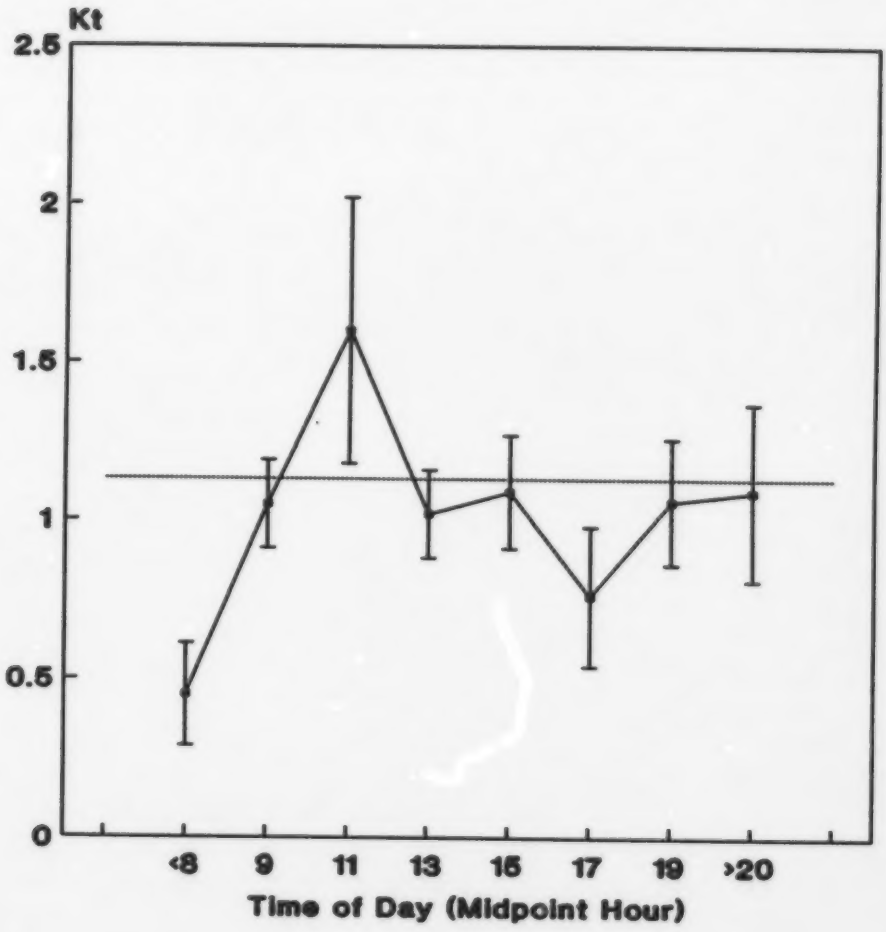

Figure 1. Average distribution of angler activity (mean K_t value +/- 2 SE) by time of day for in B.C. lakes. Average midday K_t value (dotted line) was 1.13.

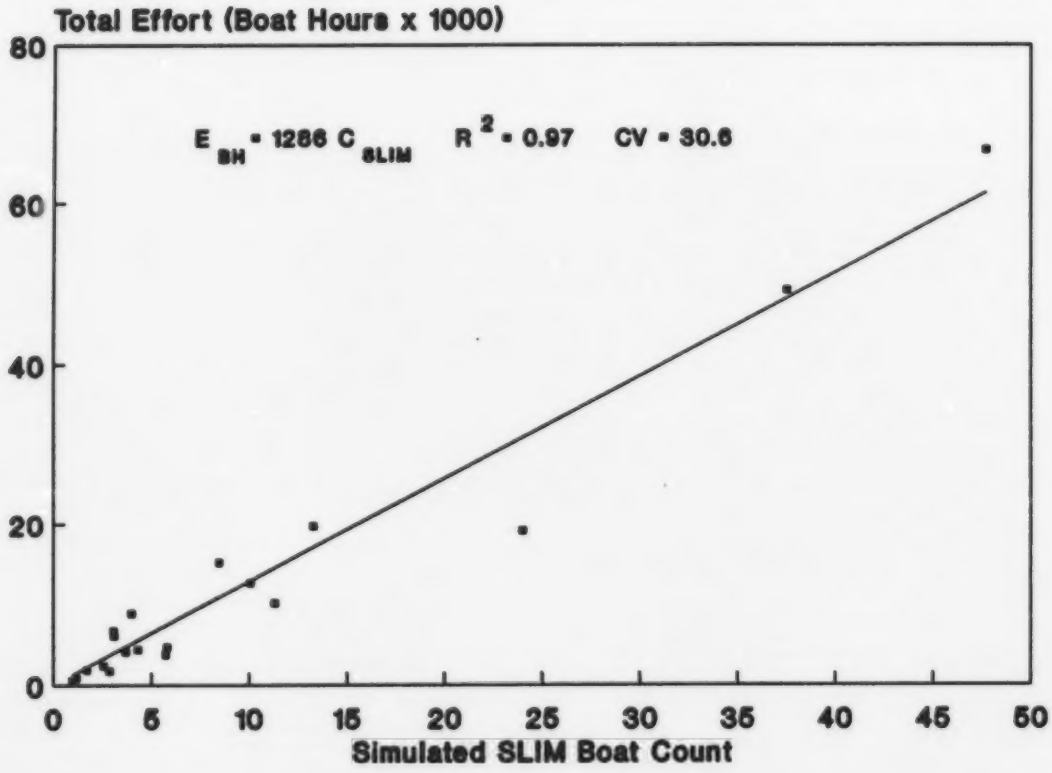

Figure 2. Total effort in boat hours versus simulated SLIM boat counts in 19 B.C. lakes

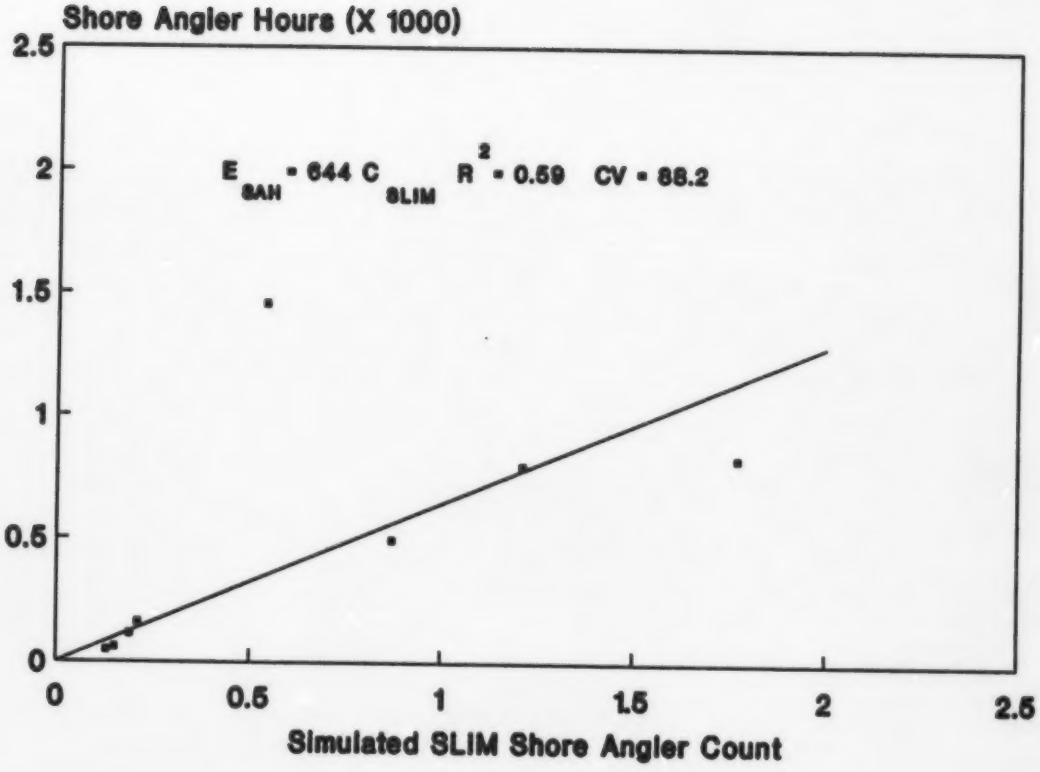

Figure 3. Shore angler hours versus simulated SLIM shore angler count in 19 B.C. lakes.

Predicted boat hour estimates were calculated for all 19 lakes and compared to actual boat hour estimates from the survey results (Table 3). A number of lakes show large residuals, both positive and negative. For example, Dragon and Pass lakes with similar simulated SLIM boat counts had actual effort estimates of 4382 and 8812 boat hours respectively. Similarly Postill and Puntzi lakes had simulated SLIM boat counts of just over 3, and effort estimates of 1716 and 6652 boat hours respectively.

Some of these deviations are due to abnormal distributions of effort and it may be possible to more closely approximate the actual effort in these cases. Obvious candidates for quantifiable adjustments include those for season length and abnormal distributions of angler activity between times of day (midday vs. morning and evening) or daytype (weekend vs. weekday).

The ratio of angler activity at midday to that before 0900 and after 1600 hrs (MD_{RATIO}; Appendix 2a) averaged 1.35 for all lakes, or midday boat count was on average 1.35 times the count at other times. This ratio varied from a low of 0.70 on Puntzi Lake, where boat counts were greater at times other than midday, to 2.16 on Postill Lake, where counts were greater at midday. For those lakes with a low ratio (<1.35) predicted effort will tend to be an underestimate of effort. For those lakes with a high ratio (>1.35) effort will be overestimated. An adjustment to correct for the daily effort distribution, taking into account the relative amounts of time associated with midday (58 percent) and other times (42 percent) is (Appendix 2b):

(4) $$E'_{BH}=E_{BH}\cdot(0.65+0.47/MD_{RATIO})$$

The average weekend effort (boat count) was 2.2 times the average weekday effort over all in lakes (WE_{RATIO}; Appendix 3a). Individual lake values ranged from 0.82 for Pass Lake, where weekend counts were less than weekday counts, to 5.33 for Headwaters Lake No. 3 where weekend counts were much greater than weekday counts. Effort predictions based on SLIM counts will therefore tend to overestimate effort for those lakes with weekend effort greater than the 2.2 times weekday average, and will underestimate effort for those lakes with weekend effort less than the average. Given that weekends account for 22 percent of the days between May 1 and October 31, the adjustment factor for the weekend/weekday ratio is (Appendix 3b):

(5) $$E'_{BH}=E_{BH}\cdot(0.38+1.35/WE_{RATIO})$$

Table 3. Comparison of actual and predicted boat hour estimates based on simulated SLIM boat counts, and effects of adjusting for effort distribution variables.

Lake	C_{SLIM}	Actual Boat Hours	Predicted Boat Hours	Residual		Effort Distribution Variables						Adjusted Boat Hour		
				Boat Hours	%	Daytype[1]	Factor	Time of Day[2]	Factor	Season (Days)	Factor	Estimate	Residual	%
Chimney	3.70	4,106	4,758	-652	16	1.83	1.12	1.20	1.04	196	1.05	5,819	1,713	42
Dragon	4.32	4,382	5,556	-1,174	27	3.44	0.77	1.20	1.04	213	1.10	4,894	512	12
Dugan	1.72	1,854	2,212	-358	19	2.06	1.04	1.15	1.06	183	1.00	2,438	584	32
Fawn	3.10	6,091	3,987	2,104	35	1.08	1.63	0.92	1.16	183	1.00	7,538	1,447	24
Headwater 1	5.73	3,752	7,369	-3,617	96	3.02	0.83	1.21	1.04	150	0.90	5,724	1,972	53
Headwater 2	1.15	876	1,479	-603	69	1.30	1.42	1.37	0.99	150	0.90	1,871	995	114
Headwater 3	0.98	520	1,260	-740	142	5.33	0.63	1.21	1.04	150	0.90	743	223	43
Jacko	8.47	15,144	10,892	4,252	28	1.50	1.28	1.26	1.02	213	1.10	15,642	498	3
Lady King	2.57	2,344	3,305	-961	41	1.94	1.08	1.13	1.07	150	0.90	3,437	1,093	47
Pass	3.98	8,812	5,118	3,694	42	0.82	2.03	0.99	1.12	183	1.00	11,636	2,824	32
Pinaus	11.32	10,156	14,558	-4,402	43	2.25	0.98	1.14	1.06	150	0.90	13,610	3,454	34
Postill	2.86	1,716	3,678	-1,962	114	3.96	0.72	1.28	1.02	135	0.85	2,295	579	34
Puntzi	3.06	6,652	3,935	2,717	41	1.14	1.56	0.80	1.24	183	1.00	7,611	959	14
Sheridan	47.70	66,680	61,342	5,338	8	1.52	1.27	1.15	1.06	213	1.10	90,836	24,156	36
Sugar	5.82	4,652	7,485	-2,833	61	2.74	0.87	1.08	1.09	166	0.95	6,743	2,091	45
Swalwell	24.00	19,120	30,864	-11,744	61	2.98	0.83	1.19	1.05	169	0.95	25,553	6,433	34
White	37.52	49,224	48,251	973	2	2.16	1.01	1.07	1.09	234	1.18	62,681	13,457	27
Whiteswan	13.29	19,728	17,091	2,637	13	1.81	1.13	1.02	1.11	183	1.00	21,437	1,709	9
Whitetail	10.08	12,628	12,963	-335	3	1.32	1.40	1.05	1.10	183	1.00	19,963	7,335	58

[1] ratio of mean weekend to mean weekday counts
[2] ratio of midday counts to the daily average

The ratio of mean counts by month to the overall season mean were generally higher early in the season than late in the season (Fig. 4). Ratios vary for individual lakes (Appendix 5). It appears that all lakes experienced an early peak in effort, followed by a steady decline to the fall. Several lakes (Chimney, Fawn, Pinaus) had relatively constant effort by month. Dragon Lake experienced an increase in effort after a relatively low use summer season. For those lakes with angling seasons significantly shorter or longer than the average season length of 178 days (approximately equal to May 1 to Oct 31), adjustments can be made on the basis of proportion of effort by month. Assuming an equal number of days per month, effort was distributed as May 21%, June 23%, July 17%, August 15% September 14% and October 10%. Given that a peak in effort occurs early in the season on most lakes, short season adjustments can be made by reducing the effort estimate by the percentage of the month not fished times the monthly effort. In most cases this will related to a late season reduction of 10%. In cases where the season is shortened by regulation, reductions will be a greater percentage. This must be interpreted by the regional biologist.

Adjustments made to predicted effort estimates based on the above increased the estimate in 12 of 19 lakes, and produced more accurate results in 12 of 19 lakes (Table 3). Residuals were actually greater in 7 of 19 lakes. These results suggest that such interpretations should be made cautiously and only in cases where the abnormality in effort distribution is large.

DISCUSSION

The relationship between the simulated SLIM boat count and boat hours and simulated SLIM shore angler counts and shore angler hours show it is possible to determine angler effort from SLIM aerial count data. High variability in the predictions as indicated by high CV values should be expected as the SLIM program counts reflect use on a sample of 1 strata covering approximately 13 % of the average available hours for angling. CV for the boat hour relationship was 30 %, indicating predictions are accurate to within 30 % of the mean. Shore angler relationship more variable (CV = 88 %), indicating less predictive value. Small sample sizes (range from 12 to 106) in the simulated data set may have increased the CV in the regression, particularly for low use lakes, but this effect is difficult to quantify. Estimates made with multiple years of SLIM data may be more accurate than the simulated data set which was based on a single year's counts.

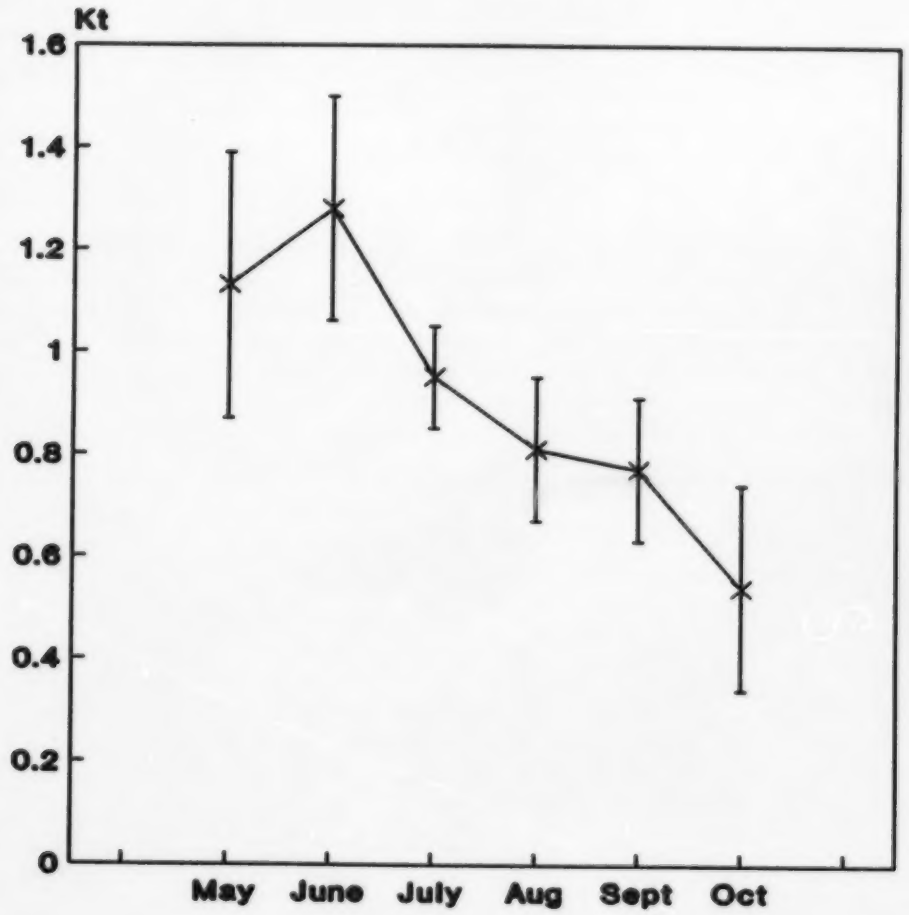

Figure 4. Mean monthly boat count activity ratios (K_t values) for 19 B.C. lakes.

The main objective of this study was to calibrate the mean midday weekend angler activity counts as collected by the SLIM program. The models proposed to estimate effort in boat hours from SLIM boat counts is as follows:

$$E_{BH}=1286 \cdot C_{SLIM}$$

and for shore anglers

$$E_{SAH}=644 \cdot C_{SLIM}$$

Boat angler hours are estimated from boat hours by multiplying by the average number of anglers per boat. Angler days are estimated by dividing angler hours by the average hours per angler day. Average values for the lakes used in this report were not different than the default standards of 2 anglers per boat and 4 hours per angler day. These values should be used unless site specific information is available.

Due to the high degree of variability in accuracy of predicted effort, results may be interpreted in terms of variation in effort distribution by daytype (weekday vs weekend) and time of day (midday versus morning/evening fisheries), and angling season length. If the characteristics of the fishery are known to be different than the average conditions used in this analysis, adjustments can be made. However these are not "universal" and may prove inappropriate for general use. If the fishery is important enough to warrant more precise estimates of use, a stratified angler survey is recommended. Analysis of trends in effort over time must be done using the mean SLIM boat count index, collected following standardized procedures.

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Appendix 1. Relative angler activity (K_t) by time of day (weekend only) in 19 B.C. lakes. K_t values represent ratio of mean boat count by time period to the daily mean. K_t for midday represents ratio of mean midday counts to the daily average.

Lake	Mean Boat Count										K_t values by time period (hrs)								
	<8	8-10	10-12	12-14	14-16	16-18	18-20	>20	Daily Avg	Midday Avg	<8	8-10	10-12	12-14	14-16	16-18	18-20	>20	Midday
Chimney	1.20	4.00	4.70	1.75	3.20	1.25	2.80		2.58	3.09	0.47	1.55	1.82	0.68	1.24	0.48	1.09		1.20
Dragon	0.80	4.30	2.67	3.50	5.60	1.00	5.00		3.42	4.09	0.23	1.26	0.78	1.02	1.64	0.29	1.46		1.20
Dugan	0.40	1.50	1.67	1.00	2.20	1.25	1.40		1.31	1.50	0.31	1.15	1.27	0.76	1.68	0.95	1.07		1.15
Fawn	1.40	2.30	2.67	2.25	3.60	2.25	5.60		2.86	2.64	0.49	0.80	0.93	0.79	1.26	0.79	2.03		0.92
Headwater 1	2.58	4.96	8.33	6.12	4.48	5.00	3.17		4.39	5.31	0.59	1.13	1.90	1.39	1.02	1.14	0.72		1.21
Headwater 2	0.00	0.33	2.33	0.33	0.20	0.00	0.33		0.52	0.71	0.00	0.63	4.48	0.63	0.38	0.00	0.63		1.37
Headwater 3	0.00	.20	1.67	0.60	0.71	1.00	0.60		0.58	0.70	0.00	0.34	2.88	1.03	1.22	1.72	1.03		1.21
Jacko		6.50	9.00	10.57	13.13	5.75	5.80	4.45	7.64	9.63		0.85	1.18	1.38	1.72	0.75	0.76	0.58	1.26
Lady King	1.55	2.11	3.00	2.88	2.33		1.90		2.16	2.43	0.72	0.98	1.39	1.33	1.08		0.88		1.13
Pass		4.71	3.67	4.00		4.33			4.15	4.12		1.13	0.88	0.96		1.04			0.99
Pinaus	6.60	11.47	17.00	12.88	11.03		9.67		10.45	11.88	0.63	1.10	1.63	1.23	1.06		0.93		1.14
Postill	1.12	2.70		3.47	3.19		1.58		2.45	3.13	0.46	1.10		1.42	1.30		0.64		1.28
Puntzi	3.80	4.75	2.33	1.90	2.25	3.25	5.20	4.00	3.22	2.57	1.18	1.48	0.72	0.59	0.70	1.01	1.61	1.24	0.80
Sheridan	15.00	49.00	50.00	38.50	25.00	32.00	32.00		39.20	45.07	0.38	1.25	1.28	0.98	0.64	0.82	0.82		1.15
Sugar	2.67	6.42	11.57	5.22	4.60		6.65		5.40	5.85	0.49	1.19	2.14	0.97	0.85		1.23		1.08
Swalwell	5.50	18.70	26.70	17.70	26.30	9.80	12.60	22.30	18.64	22.20	0.30	1.00	1.43	0.95	1.41	0.53	0.68	1.20	1.19
White		36.50	34.10	34.30	24.10	12.50	39.00		29.50	31.47		1.24	1.16	1.16	0.82	0.42	1.32		1.07
Whiteswan		13.5	17.50		11.60	7.44		19.88	13.98	14.19		0.97	1.25		0.83	0.53		1.42	1.02
Whitetail		4.56	9.78		5.00	5.22		6.22	6.16	6.44		0.74	1.59		0.81	0.85		1.01	1.05
Average											0.45	1.05	1.60	1.02	1.09	0.76	1.06	1.09	1.13
Std. Error											0.06	0.07	0.21	0.07	0.09	0.11	0.10	0.14	0.03

Appendix 2a. Ratio of midday counts to morning/evening counts for all daytypes in 19 B.C. lakes.

Lake	Mean Boat Count (All)	Midday Count (C_{MD})	Morning/Evening Count (C_{OT})	MD_{RATIO}
Chimney	1.85	2.06	1.56	1.32
Dragon	1.90	2.20	1.49	1.48
Dugan	0.89	0.98	0.76	1.30
Fawn	2.72	2.56	2.93	0.87
Headwater 1	3.03	3.67	2.04	1.80
Headwater 2	0.44	0.50	0.35	1.43
Headwater 3	0.33	0.41	0.20	2.05
Jacko	6.39	7.18	5.35	1.34
Lady King	1.59	1.77	1.30	1.36
Pass	4.52	4.56	4.33	1.05
Pinaus	7.26	8.11	5.95	1.36
Postill	1.48	1.88	0.87	2.16
Puntzi	2.98	2.55	3.63	0.70
Sheridan	31.39	33.46	29.15	1.15
Sugar	3.94	4.23	3.48	1.22
Swalwell	13.07	15.41	9.60	1.61
White	20.63	21.69	15.80	1.37
Whiteswan	10.97	10.89	11.10	0.98
Whitetail	5.46	5.59	5.26	1.06
Average				1.35
SE				0.085

Appendix 2b. Derivation of potential adjustments to boat hour estimates generated from SLIM boat counts based on knowledge of fishery characteristics.

1. Time of Day

Midday (0900-1600) represents 7/12 or 58% of the average hours available for angling; other times 5/12 or 42%.

$$E_{BH} = (C_{MD} \cdot t_{MD}) + (C_{OT} \cdot t_{OT})$$

$$E_{BH} = ((C_{MD} \cdot 0.58) + (C_{OT} \cdot 0.42)) \cdot t_{TOT}$$

$$E_{BH} = t_{TOT} \cdot (C_{MD} \cdot 0.58) + (C_{MD} \cdot \frac{0.42}{X})$$

where x is MD_{RATIO}

$$E_{BH} = t_{TOT} \cdot C_{MD} (0.58 + \frac{0.42}{X})$$

$$\frac{E_{BH}}{(0.58 + \frac{0.42}{X})} = t_{TOT} \cdot C_{MD}$$

for standard (C_{MD} = 1.35) and all other x's, t_{TOT} x C_{MD} is the same

$$\frac{E_{BH}}{0.58 + \frac{0.42}{1.35}} = \frac{E'_{BH}}{0.58 + \frac{0.42}{X}}$$

$$\frac{E_{BH}}{0.89} = \frac{E'_{BH}}{0.58 + \frac{0.42}{X}}$$

$$\frac{E'_{BH}}{E_{BH}} = \frac{0.58 + \frac{0.42}{X}}{0.89}$$

$$E'_{BH} = E_{BH} (0.65 + \frac{0.47}{X})$$

Appendix 3a. Distribution of effort as mean boat counts on weekday and weekend (including long weekend) days in 19 B.C. lakes. Ratio of weekend vs weekday counts given.

Lake	Mean Boat Count			K_t Value		WE_{RATIO}[1]
	Season	Weekday	Weekend	Weekday	Weekend	
Chimney	1.85	1.40	2.58	0.76	1.39	1.83
Dragon	1.90	0.98	3.41	0.52	1.79	3.44
Dugan	0.89	0.63	1.30	0.71	1.46	2.06
Fawn	2.72	2.63	2.86	0.97	1.05	1.08
Headwater 1	3.03	1.45	4.39	0.48	1.45	3.02
Headwater 2	0.44	0.40	0.52	0.91	1.18	1.30
Headwater 3	0.33	0.11	0.58	0.33	1.76	5.33
Jacko	6.39	5.08	7.65	0.80	1.20	1.50
Lady King	1.59	1.11	2.16	0.70	1.36	1.94
Pass	4.52	5.08	4.15	1.12	0.92	0.82
Pinaus	7.26	4.65	10.44	0.64	1.44	2.25
Postill	1.48	0.62	2.45	0.42	1.66	3.95
Puntzi	2.98	2.83	3.22	0.95	1.08	1.14
Sheridan	31.39	25.61	39.17	0.82	1.25	1.52
Sugar	3.94	1.97	5.39	0.50	1.37	2.74
Swalwell	13.07	6.22	18.63	0.48	1.43	2.98
White	20.36	13.62	29.53	0.67	1.45	2.16
Whiteswan	10.97	7.73	13.97	0.70	1.27	1.81
Whitetail	7.64	6.69	8.86	0.88	1.16	1.32
Average				0.70	1.35	2.22

1. weekend to weekday mean count ratio.

Appendix 3b. Weekend to weekday activity ratio adjustments.

The same derivation as that for time of day adjustments (Appendix 2b) applies to the WE_{RATIO}. Weekends account for 22 % and weekdays 78 % of available days. The resulting adjustment equation is:

$$E'_{BH} = E_{BH}\left(0.38 + \frac{1.35}{X}\right)$$

where x is MD_{RATIO}.

Appendix 4. Relative angler activity (K_t) by month in 19 B.C. lakes. Kt values represent ratio of mean monthly boat count to overall season mean.

Lake	Mean Boat Count									K_t values by month							
	Season	April	May	June	July	Aug.	Sept	Oct	Nov	April	May	June	July	Aug	Sept	Oct	Nov
Chimney	1.85		1.94	2.56	2.19	2.19	1.64	0.56			1.05	1.38	1.18	1.18	0.89	0.30	
Dragon	1.90		4.25	2.44	1.00	1.13	0.69	1.88			2.24	1.28	0.53	0.59	0.36	0.99	
Dugan	0.89		0.94	1.75	0.63	1.00	0.75	0.25			1.06	1.97	0.71	1.12	0.84	0.28	
Fawn	2.72		3.00	3.25	2.88	2.69	2.81	1.69			1.10	1.19	1.06	0.99	1.03	0.62	
Headwater 1	3.03		3.41	3.31	2.84	2.50					1.13	1.09	0.94	0.83			
Headwater 2	0.44			0.76	0.27	0.13						1.73	0.61	0.30			
Headwater 3	0.33			0.19	0.37	0.31						0.58	1.12	0.94			
Jacko	6.39	9.06	8.73	4.87	3.64	4.12	7.26	6.70		1.42	1.37	0.76	0.57	0.64	1.14	1.05	
Lady King	1.59		2.59	1.57	1.84	0.71					1.63	0.99	1.16	0.45			
Pass	4.52		6.00	4.70	3.75	2.67	3.00	3.33			1.33	1.04	0.83	0.59	0.66	0.74	
Pinaus	7.26		6.39	6.21	6.63	5.53					0.88	0.86	0.91	0.76			
Postill	1.48		0.57	1.78	1.41	1.73					0.39	1.20	0.95	1.17			
Puntzi	2.96		1.88	7.68	3.43	2.63	1.56	0.69			0.63	2.58	1.15	0.88	0.52	0.23	
Sheridan	31.39		21.30	56.50	40.30	31.20	21.70	10.50			0.68	1.80	1.28	0.99	0.69	0.33	
Sugar	3.94		2.27	3.79	4.01	5.19					0.58	0.96	1.02	1.32			
Swalwell	13.07		11.60	15.50	14.80	14.40	10.95	3.77			0.89	1.19	1.13	1.10	0.84	0.29	
White	20.36		42.90	21.78	17.44	11.52	17.38	11.56	3.50		2.11	1.07	0.86	0.57	0.85	0.57	0.17
Whiteswan	10.97		7.47	13.55	13.72	8.63					0.68	1.24	1.25	0.79			
Whitetail	7.64		10.87	10.29	6.44	1.78	4.57				1.42	1.35	0.84	0.23	0.60		
Average										1.42	1.13	1.28	0.95	0.81	0.77	0.54	0.17
Std. Error											0.13	0.11	0.05	0.07	0.07	0.10	
Average Monthly Effort (%)											21	23	17	15	14	10	